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(54) **TELESCOPING GUIDE CATHETER WITH PEEL-AWAY OUTER SHEATH**

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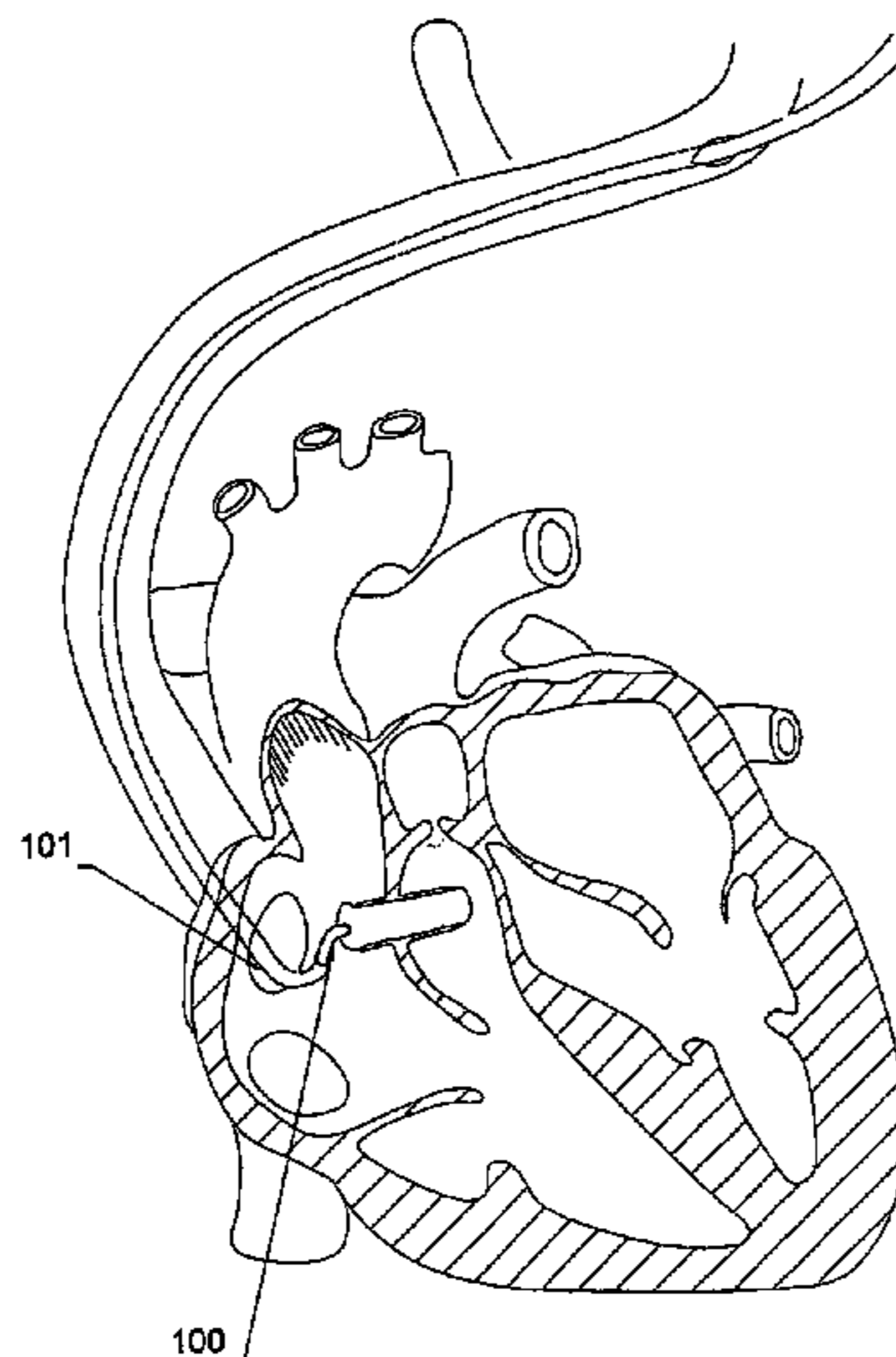
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(57) **ABSTRACT**

A guide catheter includes an outer guide having an open lumen and a longitudinal pre-stress line extending between a distal end and a proximal end of the outer guide. The outer guide has a longitudinal stiffness that facilitates transmission of forces and prevention of kinking during steering of the outer guide within cardiac vasculature and structures. An inner guide has an open lumen and is movably displaceable within the open lumen of the outer guide. At least a distal end of the outer guide and inner guide are dimensioned for passage into the patient's coronary sinus. A guide handle is connected to the proximal end of the outer guide and includes a longitudinal pre-stress line separable into at least two sections such that guide handle separation splits the outer guide along the longitudinal pre-stress line at the proximal end of the outer guide.

20 Claims, 5 Drawing Sheets



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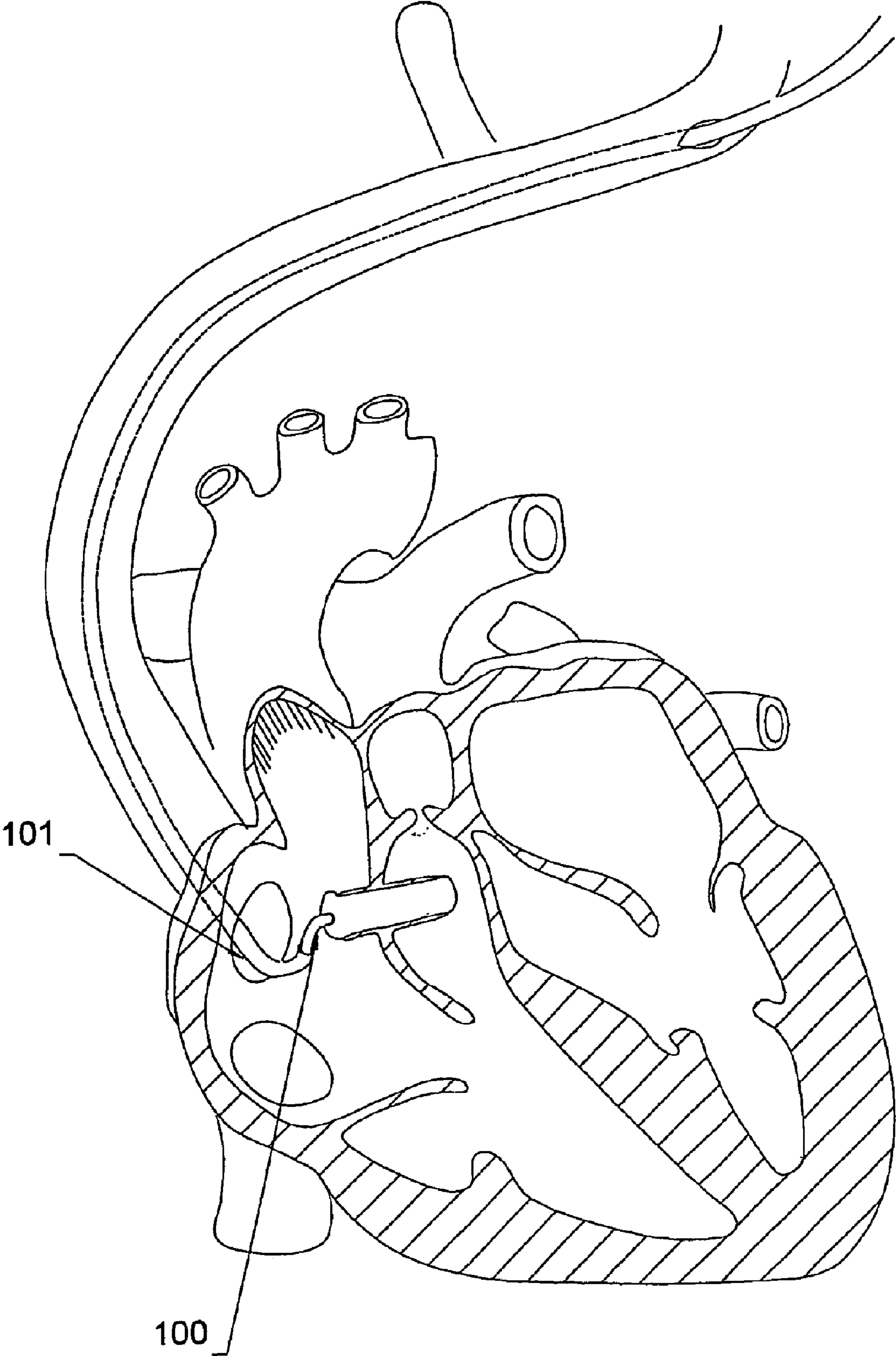


Fig. 1A

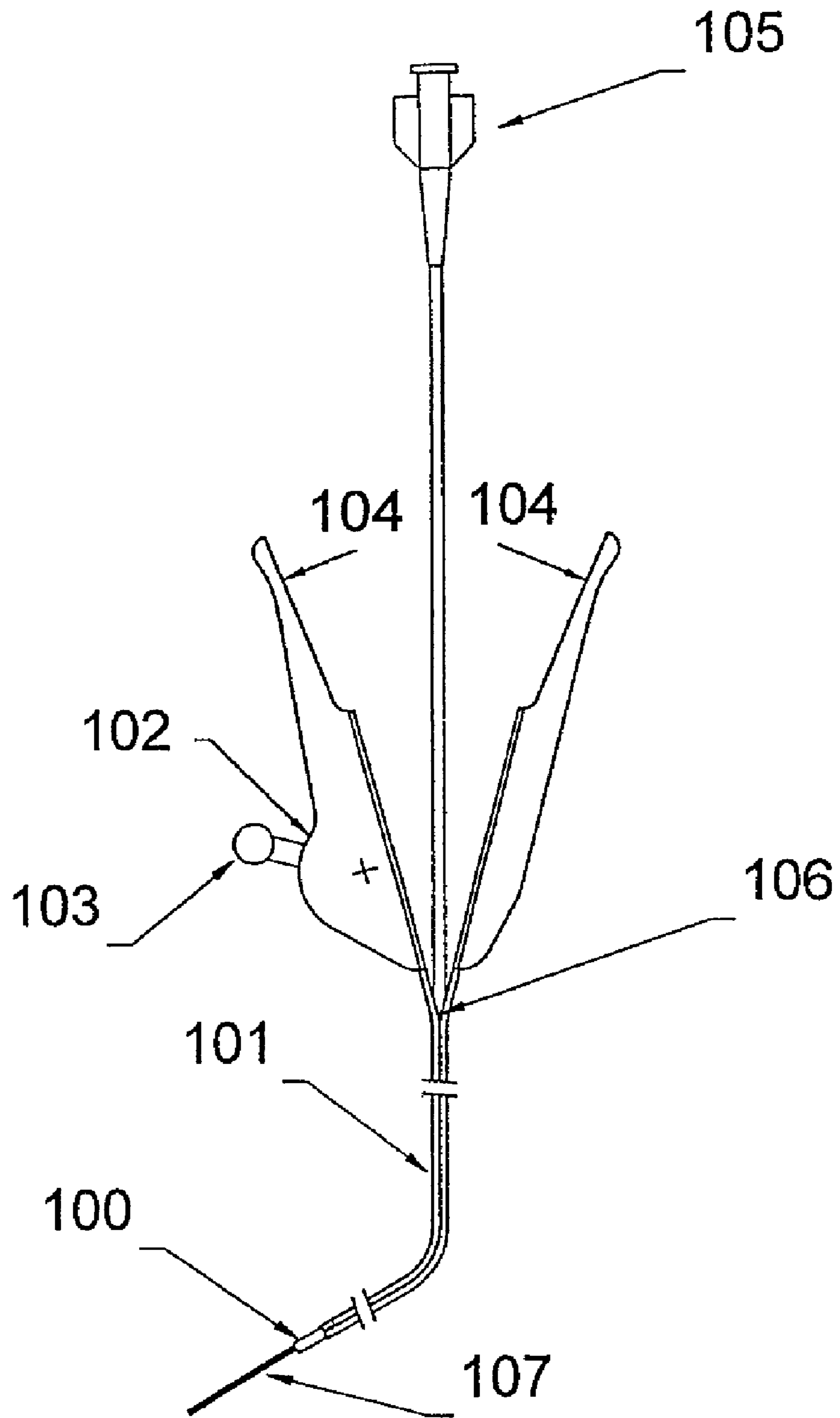


Fig. 1B

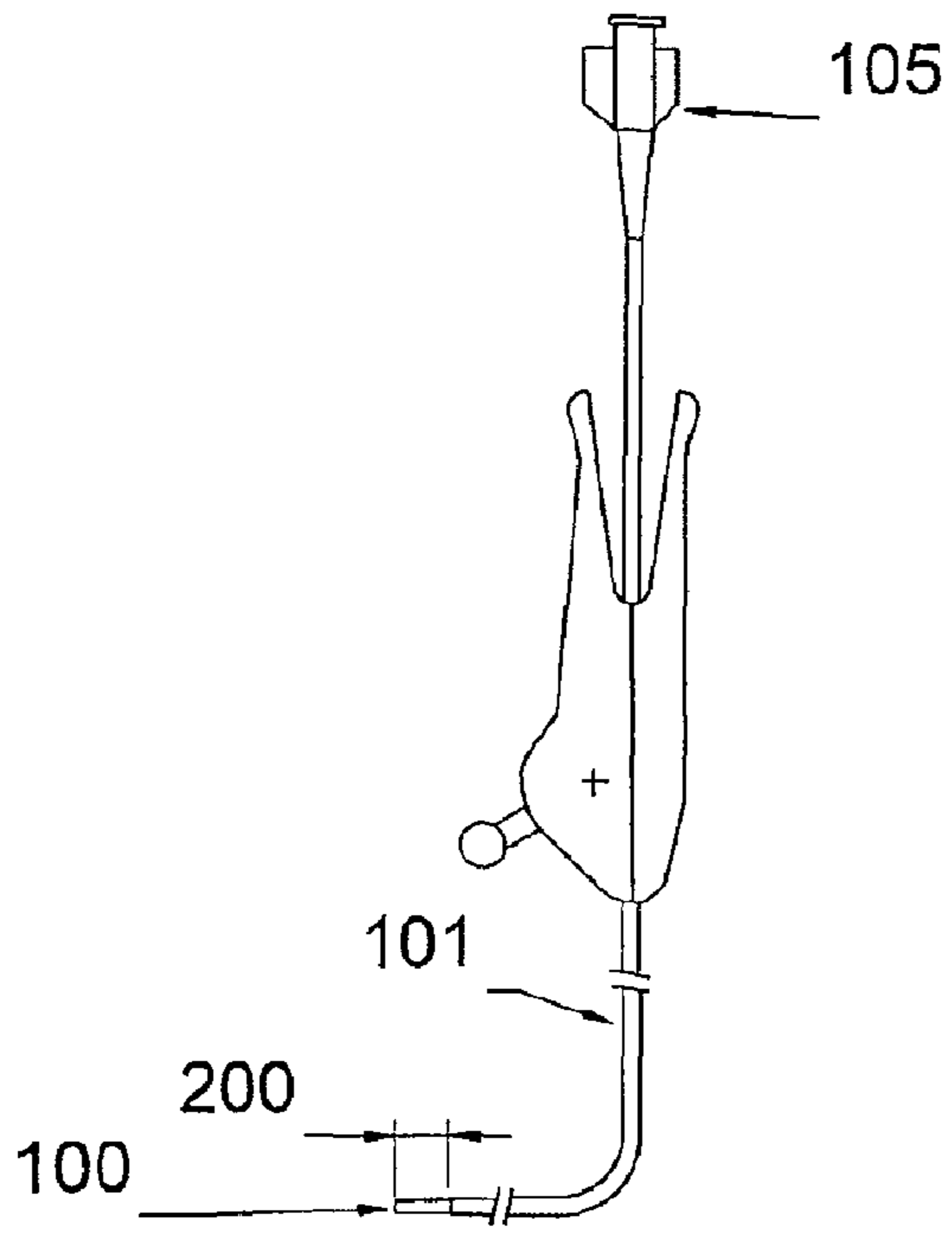


Fig. 2A

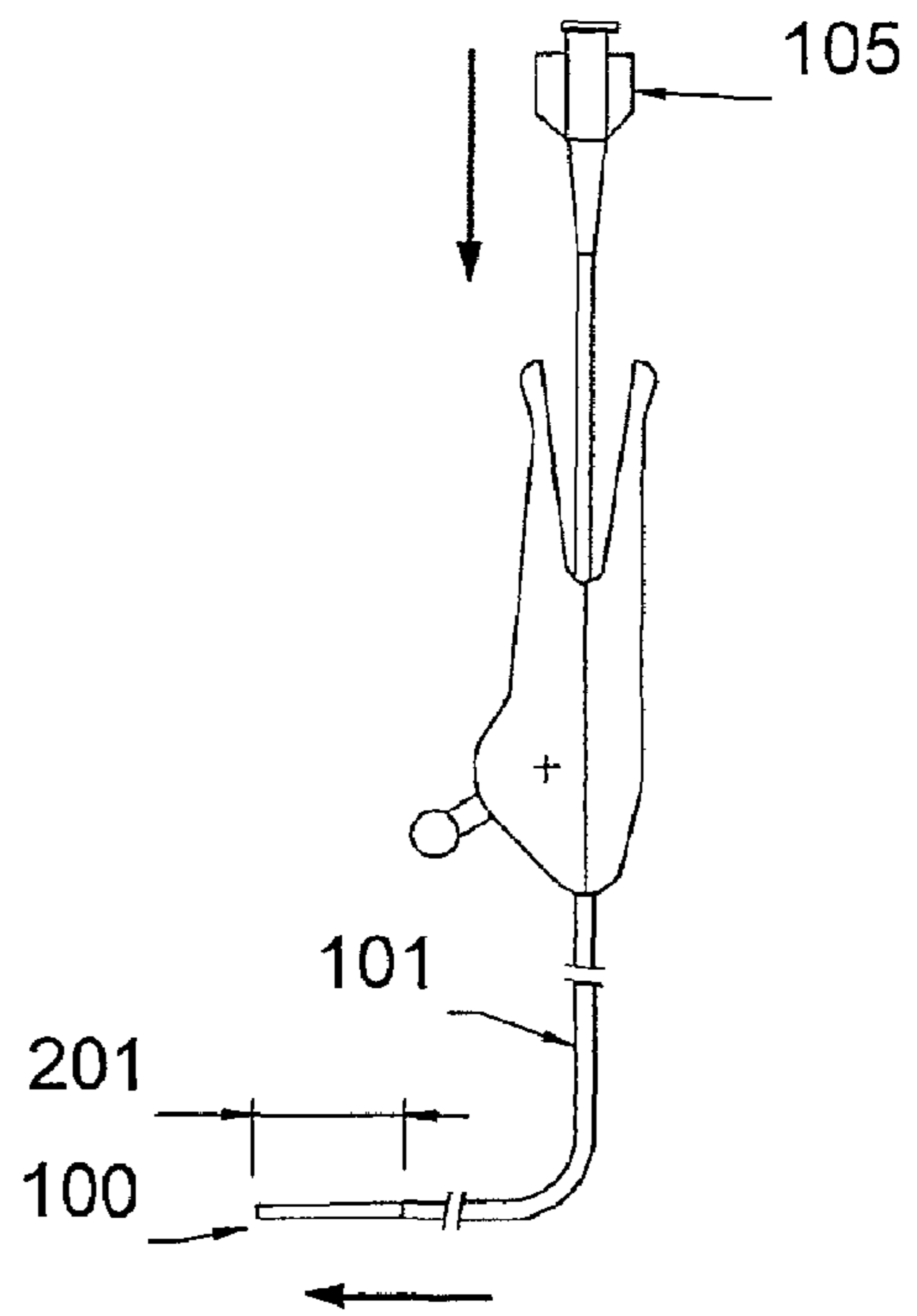


Fig. 2B

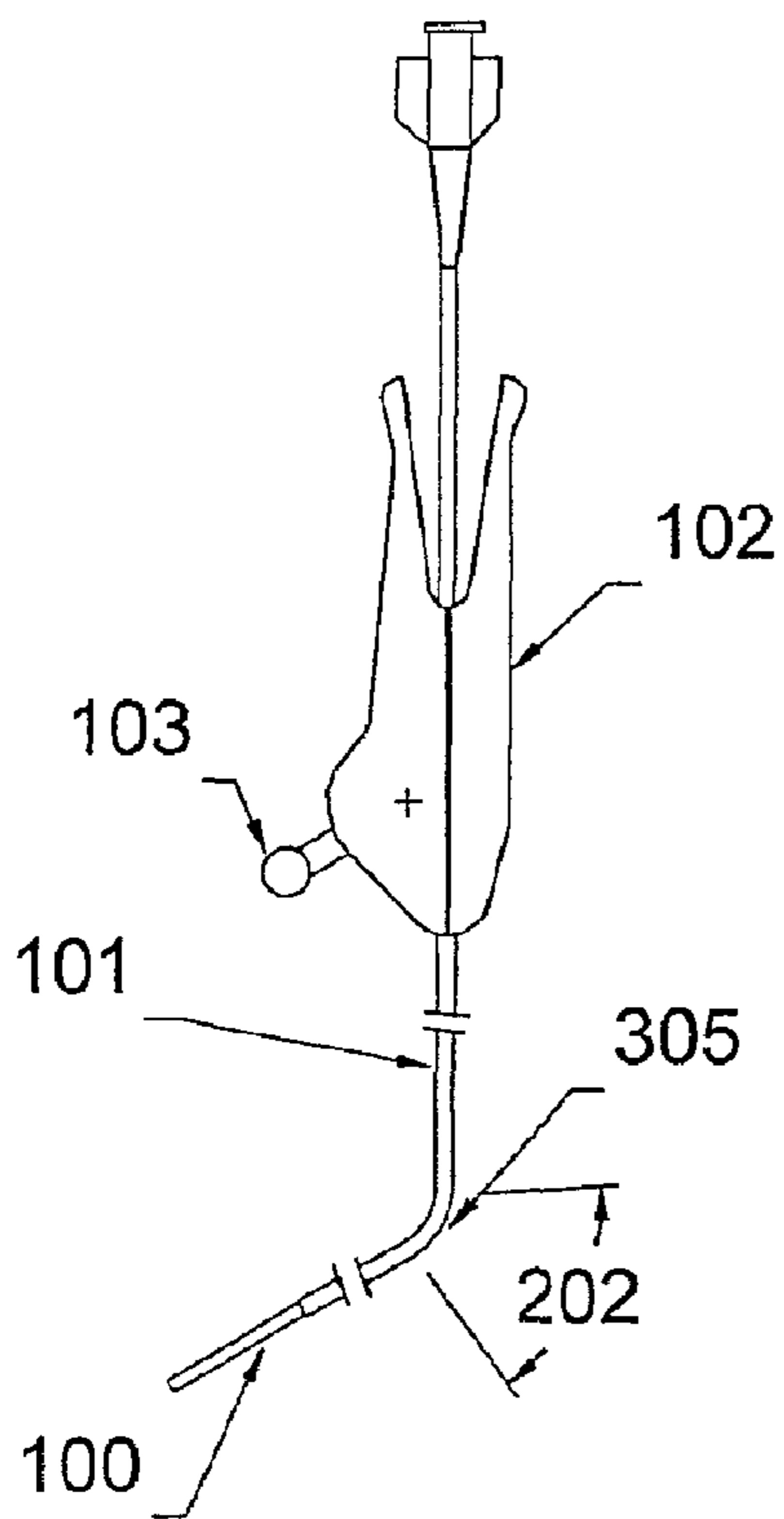


Fig. 2C

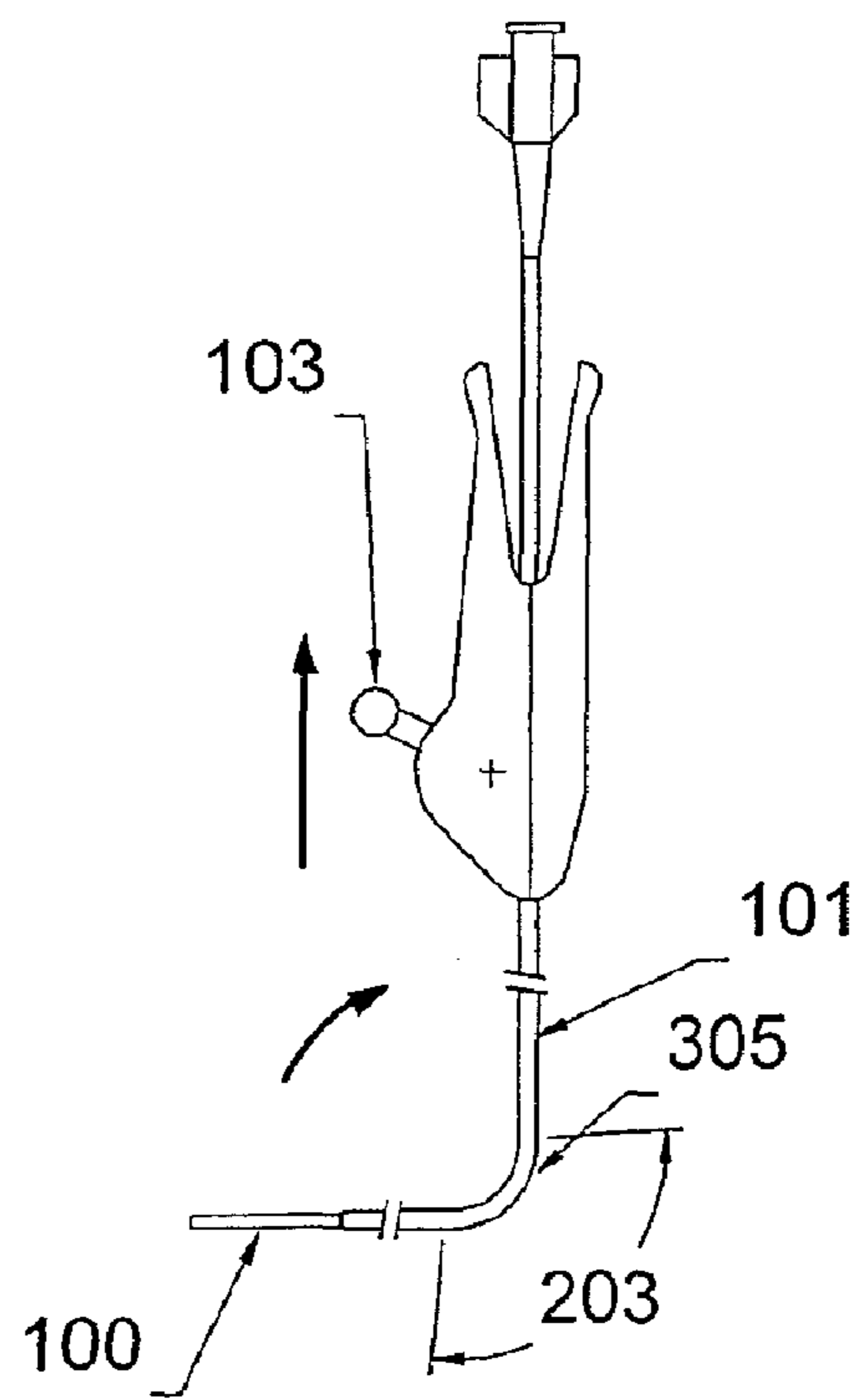
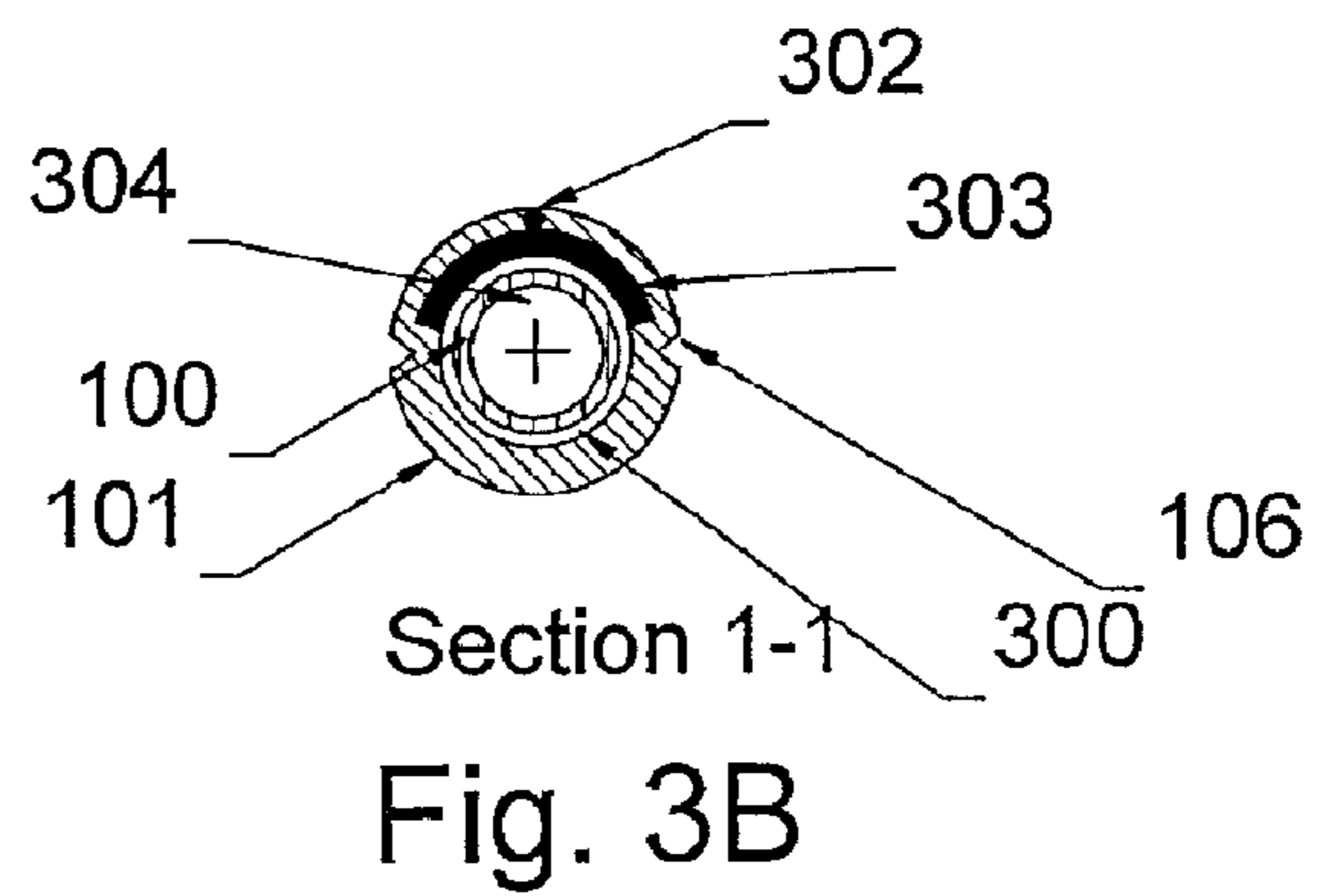
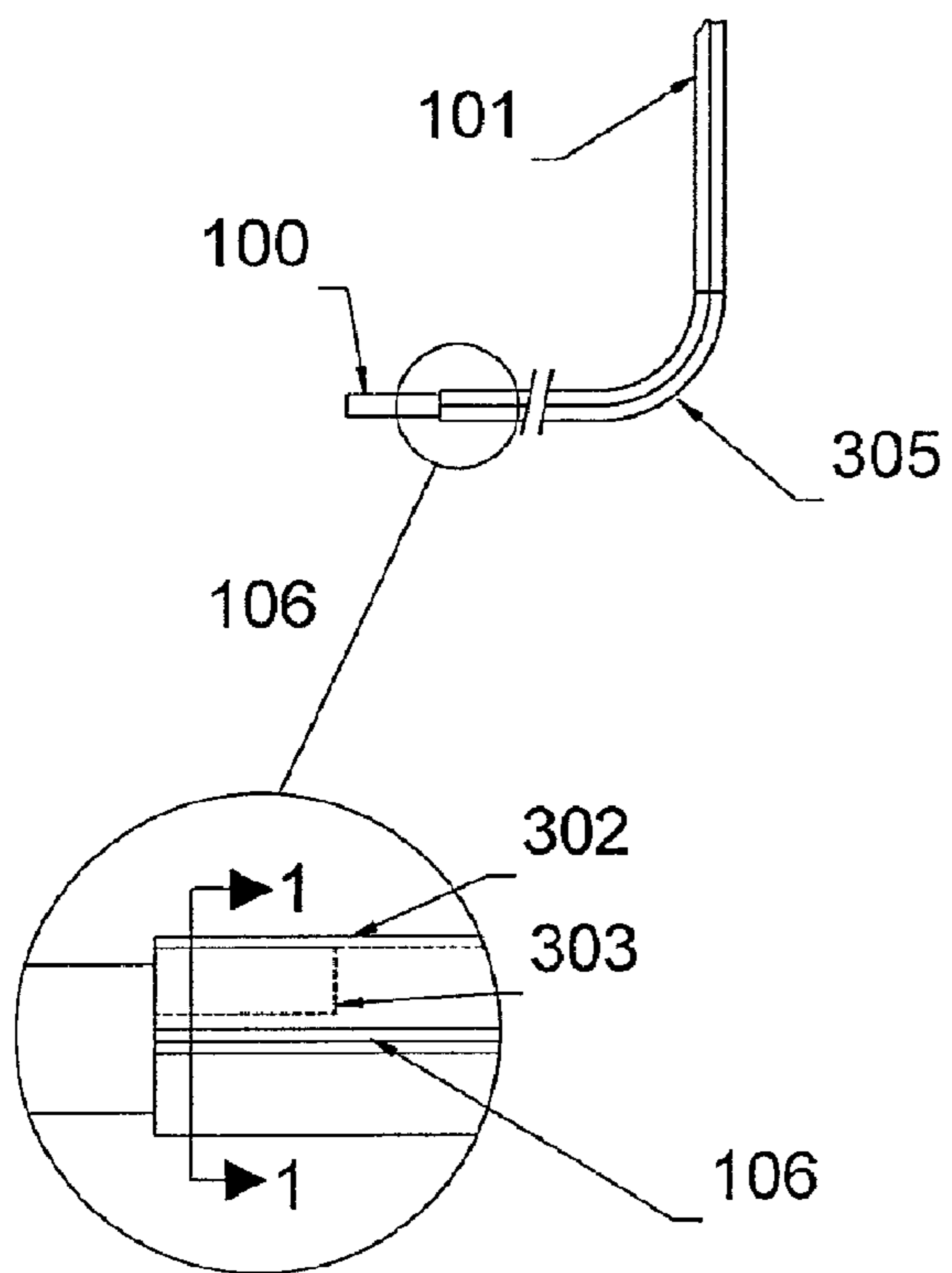
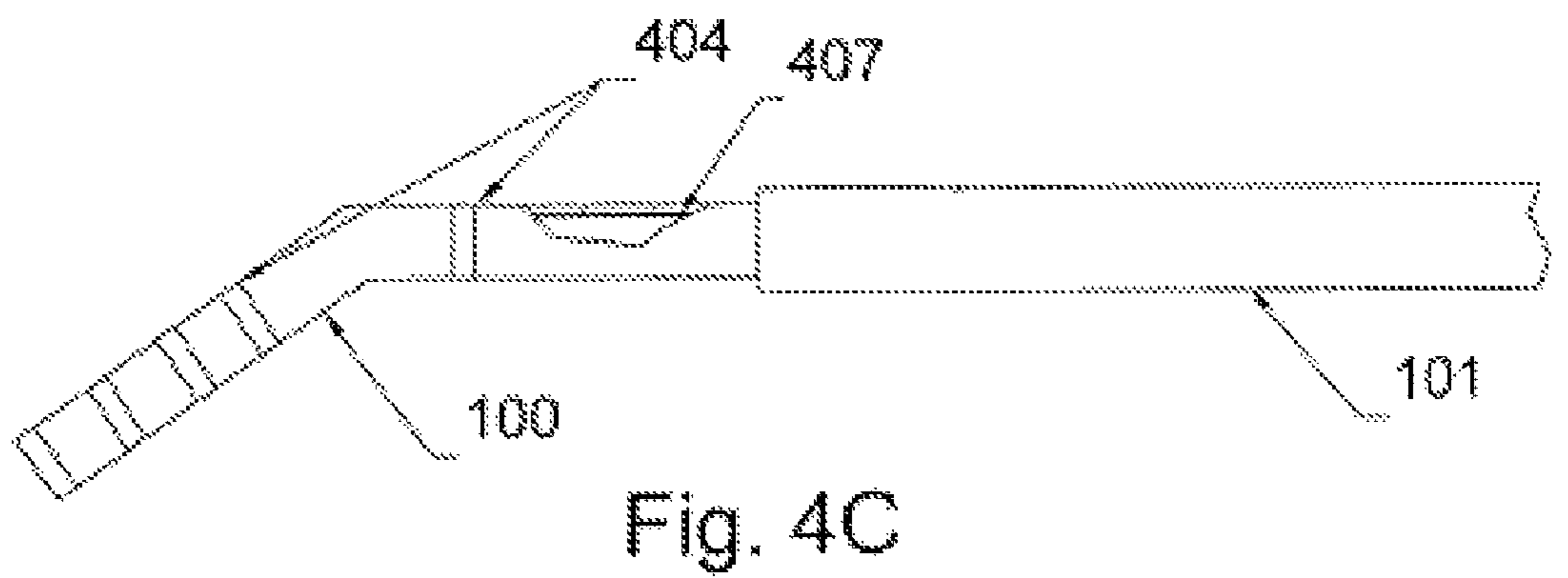
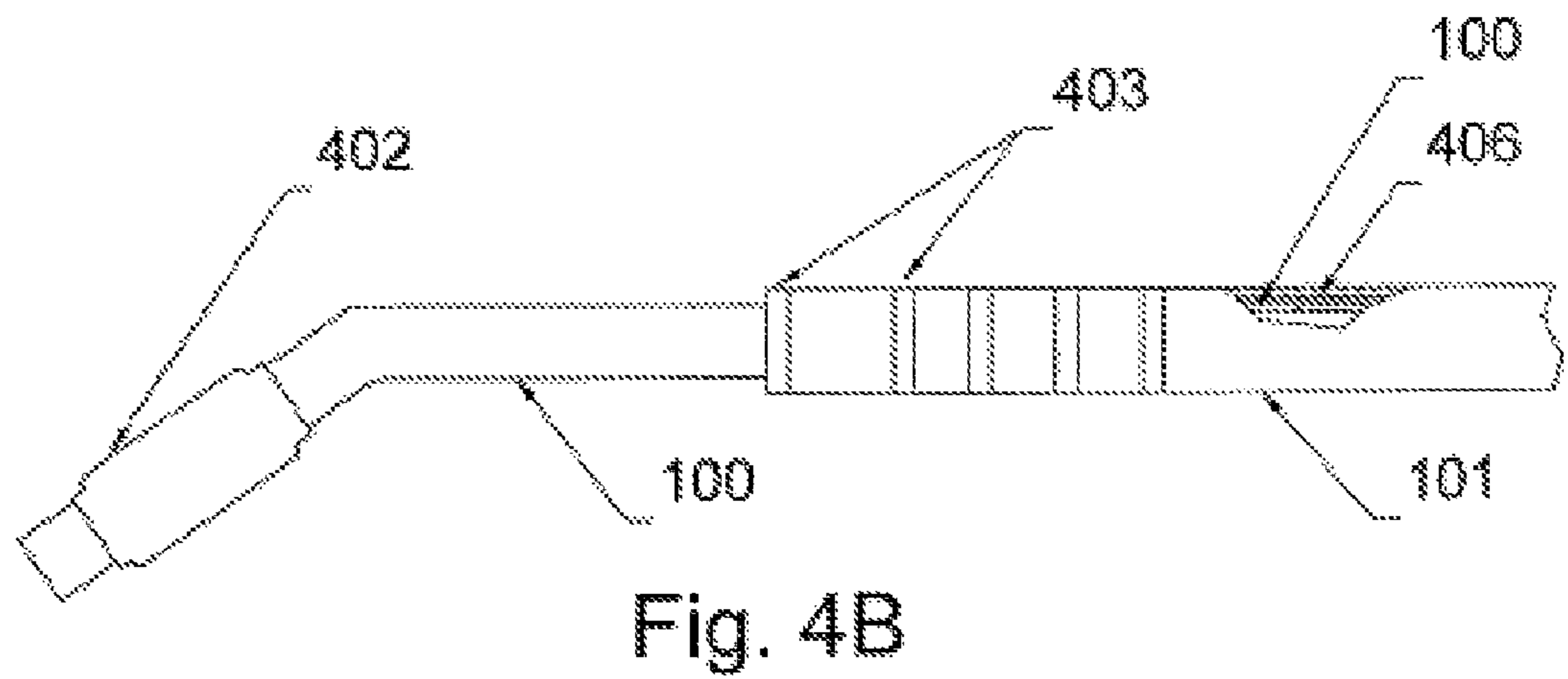
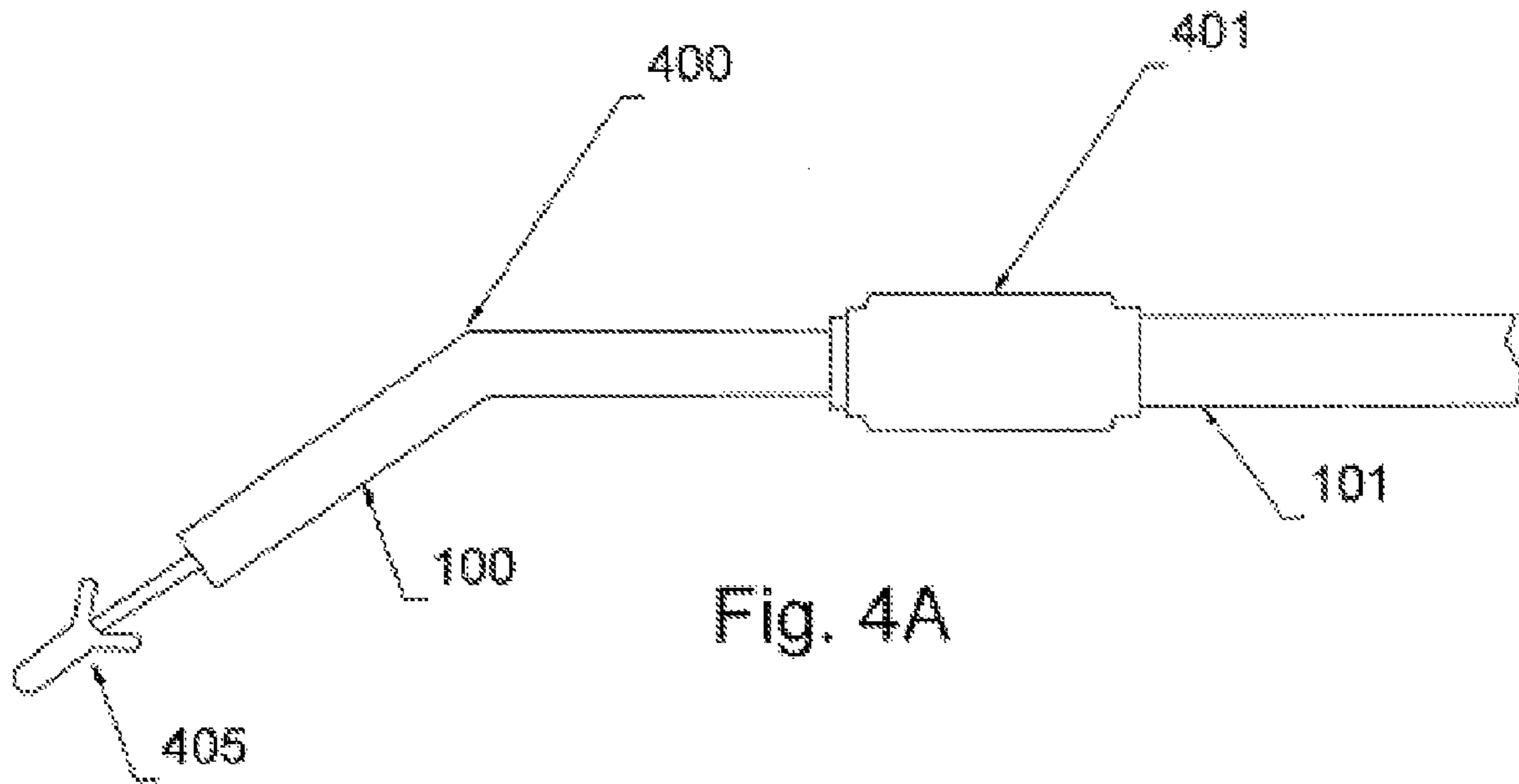


Fig. 2D





TELESCOPING GUIDE CATHETER WITH PEEL-AWAY OUTER SHEATH

RELATED PATENT DOCUMENTS

This is a continuation of U.S. patent application Ser. No. 11/529,009, filed on Sep. 28, 2006, now U.S. Pat. No. 7,697,996 issued Apr. 13, 2010, which is a continuation of U.S. Pat. No. 7,117,039 issued Oct. 3, 2006, which is a divisional of U.S. Pat. No. 6,979,319, issued Dec. 27, 2005, to which Applicant claims priority under 35 U.S.C. §120, and which are incorporated herein by reference.

FIELD OF THE INVENTION

The invention relates generally to guide catheters, and more particularly to dual-sheath, telescoping guide catheters having a peel-away outer sheath used to locate and cannulate the coronary sinus of a patient's heart.

BACKGROUND OF THE INVENTION

Guiding catheters are instruments that allow a physician to locate and cannulate vessels in a patient's heart for performing various medical procedures, including venography and implanting of cardiac pacing devices. Cannulating heart vessels requires navigating a small diameter, flexible guide through the convoluted vasculature into a heart chamber, and then into a destination heart vessel. Once the destination heart vessel is reached, the catheter acts as a conduit for insertion of payloads into the vessel.

A commonly accessed destination vessel for cardiac pacing lead insertion is the coronary sinus. A pre-shaped guiding catheter is typically used to blindly locate the coronary sinus ostium. This endeavor, however, is complicated by the fact that the location of the coronary sinus ostium may vary appreciably from one patient to another, especially among patients with diseased hearts. Oftentimes, the clinician is entirely unable to locate the coronary sinus ostium using the guiding catheter, and must resort to finding the ostium by "mapping" (interpreting localized bipolar waveforms) using an electrophysiological (EP) catheter and an ECG monitor. After the ostium is located, the guiding catheter is typically used to inject radiographic contrast media into the coronary sinus to highlight the associated venous system, and then a pacing lead is installed within one of the coronary branches.

Complicating this scenario is the dynamic structural deformation of the heart chambers that occurs from normal cardiac activity during the procedure. This further increases the difficulty of guiding a catheter to its destination. Presently, a considerable amount of time is often spent by the physician when manipulating such catheters within cardiac structures, such as the right atrium, simply trying to locate an anatomical feature of interest, such as the coronary sinus ostium.

Guiding catheter systems are typically configured with a profile that is optimized for the intended method of access. In the case of accessing the coronary sinus via the right atrium, a catheter with a distal contour including a relatively sharp bend will point the catheter towards the likely location of the coronary sinus once the right atrium is reached. The contours of pre-shaped guiding catheters are generally fixed, and this is typically achieved in production by constraining the distal end within a shaping fixture while warming them until they assume the intended shape (i.e., by "heat setting" their polymer shaft).

Guiding catheters are often designed to be relatively stiff at least along a substantial part of their proximal length. This

allows easier insertion, as the stiffer catheter transmits pushing forces and is less likely to kink when encountering a bend or obstruction. However, a stiffer catheter is more prone to accidental dislodgment of payloads, such as pacing leads, when the catheter is retracted.

There is a need for an improved guide catheter that can dynamically account for anatomical variations and defects associated with the destination structures. There exists a further need for a guide catheter that provides for easier catheter insertion and yet is less likely to dislodge an implanted payload during catheter retraction. The present invention fulfills these and other needs, and addresses other deficiencies of prior art implementations and techniques.

SUMMARY OF THE INVENTION

The present invention is directed to a guide catheter for cannulating a vessel of a patient's heart. According to one embodiment of the invention, the guide catheter includes an outer guide having an open lumen and a longitudinal pre-stress line extending between a distal end and a proximal end of the outer guide. An inner guide having an open lumen is movably disposed within the open lumen of the outer guide such that the inner guide can rotate axially and translate longitudinally relative to the outer guide. The guide catheter further includes a guide handle. The guide handle has a distal end connected to the proximal end of the outer guide. The guide handle is separable into at least two sections such that guide handle separation splits the outer guide along the longitudinal pre-stress line at the proximal end of the outer guide. The outer guide further splits along the longitudinal pre-stress line upon outer guide retraction in a proximal direction relative to the inner guide.

In one aspect of the invention, the longitudinal pre-stress line on the outer guide includes a V-shaped notch on a surface of the outer guide. The outer guide can include a second longitudinal pre-stress line situated oppositely the first longitudinal pre-stress line on the surface of the outer guide. The second longitudinal pre-stress line may also include a V-shaped notch on a surface of the outer guide.

In one configuration, the guide catheter further includes a steering tendon disposed within the outer guide. A distal end of the steering tendon is connected to the distal end of the outer guide, such that the steering tendon deflects the distal end of the outer guide upon application of a tensile force to a proximal end of the steering tendon.

In another configuration, a steering mechanism is connected to the proximal end of the steering tendon. The steering mechanism applies a tensile force to the proximal end of the steering tendon. The steering mechanism can be connected to the guide handle. The steering mechanism may further include a steering handle pivotably mounted to the guide handle.

In one aspect of the invention, the distal end of the inner guide includes a pre-formed curve.

In another embodiment of the invention, the guide catheter further includes at least one electrode on the distal end of one or both of the inner guide and outer guide. At least one electrical conductor is coupled to the at least one electrode, the at least one conductor disposed within one or both of the inner guide and outer guide.

In another embodiment of the invention, an occlusion device may be connected near the distal end of the catheter. In one configuration, the occlusion device is connected to the distal end of the outer guide. In another configuration, the occlusion device is connected to the distal end of the inner guide.

In yet another embodiment of the invention, a guide catheter for delivery of a payload into a patient's heart includes an outer guide. The outer guide includes an open lumen and a longitudinal pre-stress line extending between a distal end and a proximal end of the outer guide. An inner guide is movably disposed within the open lumen of the outer guide such that the inner guide can rotate axially and translate longitudinally relative to the outer guide. The inner guide includes an open lumen adapted to receive the payload. The guide catheter further includes a guide handle. The guide handle has a distal end connected to the proximal end of the outer guide. The guide handle is separable into at least two sections such that guide handle separation splits the outer guide along the longitudinal pre-stress line at the proximal end of the outer guide. The outer guide further splits along the longitudinal pre-stress line upon outer guide retraction in a proximal direction relative to the inner guide. The inner guide secures the payload against dislodgment during outer guide retraction.

In another embodiment of the invention, a method of inserting a payload into a coronary sinus of a patient's heart includes providing a guide catheter having an outer guide, an inner guide, and a guide handle. The outer guide includes an open lumen and a longitudinal pre-stress line extending between the distal and proximal ends of the outer guide. The inner guide includes an open lumen adapted to receive the payload and is movably disposed within the open lumen of the outer guide. The inner guide can rotate axially and translate longitudinally relative to the outer guide. The guide handle includes a distal end connected to the proximal end of the outer guide. The guide handle is separable into at least two sections such that guide handle separation splits the outer guide along the longitudinal pre-stress line at the proximal end of the outer guide. The outer guide further splits along the longitudinal pre-stress line upon outer guide retraction in a proximal direction relative to the inner guide.

The method further involves inserting a distal end of the guide catheter through a patient's right atrium via an access vessel. The inner guide is axially extended and retracted relative to the outer guide to direct a distal end of the inner guide for finding and cannulating the patient's coronary sinus. A payload is inserted through the proximal end of the inner guide into the patient's coronary sinus.

The outer guide is removed by separating the guide handle into at least two sections to split the outer guide along the longitudinal pre-stress line. The outer guide is further split along the longitudinal pre-stress line by retracting the outer guide in a proximal direction relative to the inner guide. The inner guide secures the payload against dislodgment during outer guide retraction.

Another embodiment of the method involves distally advancing the outer guide over the inner guide to seat the outer guide in the coronary sinus after finding and cannulating the patient's coronary sinus. The inner guide is proximally retracted to remove the inner guide from the outer guide. The payload is then inserted through the proximal end of the outer guide to insert the payload into the patient's coronary sinus. The outer guide is removed by separating the guide handle into at least two sections to split the outer guide along the longitudinal pre-stress line. Then, retracting the outer guide in a proximal direction relative to the payload further splits the outer guide along the longitudinal pre-stress line.

In one aspect of the above methods, the payload includes a pacing lead. Another aspect of the methods involves the guide catheter further including a steering tendon disposed within the outer guide. A distal end of the steering tendon connects to

the distal end of the outer guide. The steering tendon deflects the distal end of the outer guide upon application of a tensile force to a proximal end of the steering tendon. The methods further involve locating and cannulating the patient's coronary sinus by additionally applying a tensile force to the proximal end of the steering tendon to direct the distal end of the guide catheter.

The above summary of the present invention is not intended to describe each embodiment or every implementation of the present invention. Advantages and attainments, together with a more complete understanding of the invention, will become apparent and appreciated by referring to the following detailed description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a cut-away view of a patient's heart, showing a catheter embodying features of the present invention deployed within the heart;

FIG. 1B is an external view of a catheter embodying features of the present invention;

FIG. 2A is an external view of the catheter shown in FIG. 1B illustrating a retractable inner guide;

FIG. 2B is an external view of the catheter shown in FIG. 1B further illustrating the inner guide retraction;

FIG. 2C is an external view of the catheter shown in FIG. 1B illustrating a deflectable outer guide;

FIG. 2D is an external view of the catheter shown in FIG. 1B further illustrating the outer guide deflection;

FIG. 3A is a view of the distal end of an outer guide of the present invention showing a steering tendon attachment;

FIG. 3B is a transverse cross section view of the distal end of the outer guide corresponding to Section 1-1 of FIG. 3A;

FIG. 4A is a view of the distal end of a catheter showing an occlusion balloon attached to the outer guide according to an embodiment of the present invention;

FIG. 4B is a view of the distal end of a catheter showing electrodes provided at the distal end of the outer guide and an occlusion balloon provided at the distal end of the inner guide according to another embodiment of the present invention; and

FIG. 4C is a view of the distal end of a catheter showing electrodes provided at the distal end of the inner guide according to a further embodiment of the present invention.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail herein. It is to be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the invention is intended to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE VARIOUS EMBODIMENTS

In the following description of the illustrated embodiments, references are made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration, various embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized, and structural and functional changes may be made without departing from the scope of the present invention.

With reference to FIG. 1A, a distal end of a guide catheter is illustrated in accordance with an embodiment of the present

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invention. The guide catheter includes an inner guide **100** and an outer guide **101**. The guide catheter is shown deployed within a patient's heart, accessing the coronary sinus via the right atrium. A distal end of the inner guide **100** extends from the outer guide **101** as the inner guide **100** is advanced towards the coronary sinus ostium.

Turning now to FIG. 1B, a guide catheter is shown embodying features of the present invention. The inner guide **100** is movably disposed within an open lumen of the outer guide **101** (best seen in FIG. 3B) such that the inner guide **100** can translate longitudinally and rotate axially within the outer guide **101**. The inner guide **100** may contain a proximal attachment. In the embodiment shown in FIG. 1B, the proximal attachment is a wing luer **105**. The inner guide **100** typically includes an open lumen (best seen in FIG. 3B), and the open lumen can be adapted to receive a payload **107**.

The outer guide **101** is fixably attached to a distal end of a guide handle **102**. The guide handle **102** includes a mechanism that facilitates separation of the guide handle **102** into at least two sections upon application of a splitting force **104**. Separation of the guide handle **102** provides leverage to assist in easily splitting the outer guide **101**. Once the outer guide **101** is split where the outer guide **101** attaches to the guide handle **102**, proximal retraction of the outer guide **101** relative to the inner guide **100** can further split the outer guide **101**.

The outer guide **101** is typically formed of a molded elastomer tubing. An elastomeric material such as a high durometer Pebax can provide the desired longitudinal stiffness. It is also possible to include an inner lubricious lining, formed from a material such as PTFE. The outer guide **101** may also include a soft distal tip to prevent tissue abrasion along the venous pathways.

The outer guide **101** includes a longitudinal pre-stress line **106** extending between the distal and proximal ends of the outer guide **101**. The pre-stress line **106** is typically a V-shaped notch or groove formed on a surface of the outer guide **101**. Other configurations of a pre-stress line are possible, such as a fiber or wire longitudinally embedded within the outer guide **101**.

At least one pre-stress line **106** is required to allow splitting the outer guide **101**. Two pre-stress lines **106** can be employed, the two pre-stress lines **106** typically being distributed oppositely (180 degrees apart) around a transverse cross sectional perimeter of the outer guide **101**. The distribution of two pre-stress lines **106** on the outer guide **101** are best seen in FIG. 3B.

A guide catheter according to the present invention will generally be used to assist in implanting the payload **107** into a cardiac destination vessel. In one aspect of the present invention, the inner guide **100** is more compliant than the outer guide **101**. A relatively rigid outer guide **101** is beneficial during insertion as it helps to prevent kinking and allows better transmittal of pushing forces. The inner guide **100** is commonly more flexible to afford greater maneuverability within a constricted heart chamber.

When a catheter embodying aspects of the present invention is advanced through the venous pathways, the inner guide **100** can be retracted within the outer guide **101**. The inner guide **100** is relatively compliant compared to the outer guide **101**, so the inner guide **100** tends to assume the shape of the outer guide **101** when retracted. Once the distal tip of the outer guide **101** has located a chamber of the heart, such as the right atrium, the flexible inner guide **100** is then extended from the distal end of the outer guide **101**.

FIGS. 2A and 2B illustrate extension of the inner guide **100** relative to the outer guide **101**. In FIG. 2A, the distal end of the inner guide **100** extends from the outer guide **101** by a length

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200. FIG. 2B shows the result of pushing the proximal end of the inner guide **100**, the direction of inner guide **100** movement being represented by the bold arrows. Pushing the inner guide **100** in the distal direction causes the extended length of the inner guide **100** to be increased to a length **201**. The wing luer **105** attached to the inner guide **100** can serve as a convenient grip from which to apply forces for adjustably extending and retracting the inner guide **100** while probing for the feature of interest at the distal end of the catheter.

As is best seen in FIG. 4A, the inner guide **100** may also include a pre-formed curve **400**. When the inner guide **100** is extended beyond the outer guide **101** within a heart chamber, the inner guide's distal end takes on the shape of the pre-formed curve **400**. The pre-formed curve **400** can be optimized for locating a feature of interest. One common feature of interest in pacing lead implantation is the coronary sinus ostium, which is an access point to the coronary sinus. Pacing leads are often implanted in a destination vessel branching from the coronary sinus.

To allow optimal access to the coronary sinus ostium, the pre-formed curve **400** may include a bend angle ranging from about 20 to about 100 degrees. The pre-formed curve **400** may be located from about 1 centimeter to about 10 centimeters from the distal tip of the inner guide **100**.

In one configuration, the inner guide **100** is formed from an extruded polymer tube with a thermoset pre-formed curve at the distal end. An elastomer such as Pebax may be used, usually in a lower durometer formulation that is used in the outer guide **101**. Typically, the inner guide **100** will have a lubricious lining along its inner surface. The inner guide **100** may include a soft distal tip to reduce tissue abrasion.

The extended distal end of the inner guide **100** can be rotated axially and extended longitudinally once it is in the access chamber of the heart. Extension and rotation of the inner guide **100** is useful in locating the feature of interest. Once the feature of interest is found, the inner guide **100** may be advanced as far as needed and seated within the destination vessel.

After the inner guide **100** is seated, a payload, such as a pacing lead **405**, can be inserted through the inner guide **100**. The pacing lead **405** is shown extending beyond the inner guide **100** in FIG. 4A. The pacing lead **405** is generally introduced into the inner guide **100** from the proximal end of the guide catheter. Once the pacing lead **405** is inserted into the destination vessel, the clinician may perform checks to determine if implantation was successful. For example, electrical measurements may be performed on the pacing lead **405** to ensure the pacing electrode has sufficiently contacted with the heart tissue to operate effectively.

After successful pacing lead **405** implantation, it is necessary to remove the guide catheter from the venous pathway. The catheter may be designed to be relatively rigid to assist the insertion procedure, but this rigidity has a drawback during removal. When the catheter is being removed, a more rigid catheter will tend to displace the pacing lead **405**.

The relatively compliant inner guide **100** with the splittable outer guide **101** according to the present invention can provide a guide catheter with advantages of both easy insertion and safe retraction. Referring again to FIG. 1B, retracting the catheter can begin by first splitting the outer guide **101**. The guide handle **102** can be separated by applying a force **104** to appropriate locations of the handle. The guide handle **102** is fixably mounted to the outer guide's proximal end, so separation of the guide handle **102** also splits the proximal end of the outer guide **101**.

Once the proximal end of the outer guide **101** is split, the outer guide **101** can be proximally retracted. Typically, the

retraction is performed in such a manner as to impart a splitting force on the longitudinal pre-stress line **106** of the outer guide **101** as it is being pulled out of the entry point. In a case where the outer guide **101** includes two longitudinal pre-stress lines **106**, outer guide splitting can be accomplished by grasping each split half of the outer guide **101** and pulling at an angle that provides both axial and radial forces, thus retracting and splitting the outer guide **101** at the same time.

The splitting of the outer guide **101** is beneficial as it allows the outer guide **101** to be removed without the guide **101** disturbing any attachments that may be mounted on the proximal end of the inner guide **100**. For example, a wing luer **105** may be mounted to the proximal end of the inner guide **100**, as shown in FIG. 1B. Splitting the outer guide **101** during outer guide retraction enables the outer guide **101** to be retracted without interfering with the wing luer **105**. Splitting the outer guide **101** also enables the clinician to secure the inner guide **100** near the percutaneous access point during outer guide **101** retraction.

While the outer guide **101** is being retracted, the inner guide **100** helps to prevent dislodgment of the payload **107**. The outer guide **101** will typically impart axial shear forces on the inner guide **100** during outer guide **101** retraction. The inner guide **100** can be held secure by the clinician to resist the axial shear forces. The inner guide **100** is typically better able to resist being dislodged during outer guide **101** retraction than is the payload **107**. If the inner guide **100** is dislodged, a lubricious lining within the inner guide **100** helps ensure that only minimal disruptive forces act on the payload **107**. The inner guide **100**, if dislodged, can be re-seated as necessary during the outer guide **101** retraction procedure.

After the outer guide **101** has been fully removed, the inner guide **100** will still effectively cannulate a path to the destination vessel until such time as inner guide **100** removal is required. The inner guide **100** is relatively compliant and may have an inner lubricious lining, so retraction of the inner guide **100** is less likely to dislodge the payload **107**.

In an alternate method, it may be desirable to utilize the outer guide **101** to cannulate the destination vessel. The outer guide **101** has a larger lumen than the inner guide **100**, and can accommodate a larger payload. In this method, the destination vessel is located and cannulated by the inner guide **100** as previously described. The outer guide **101** is then distally advanced over the inner guide **100** until the outer guide **101** is seated in the destination vessel. The inner guide **100** can then be proximally retracted until it is removed from the outer guide **101**.

In this alternate method, the payload **107** can then be advanced through the lumen of the outer guide **101**. When the procedure requires removal of the guide catheter, the outer guide **101** can be split at the guide handle **102** as previously described. The outer guide **101** is further split while being proximally retracted. The splitting serves to prevent interference between the outer guide **101** and any proximal attachments that may be connected to the payload **107**.

Turning now to FIG. 3A, another embodiment of the present invention is shown that includes a steering tendon **302** and a deflection location **305**. The steering tendon **302** and deflection location **305** are used to assist guiding the distal end of the guide catheter during insertion.

The steering tendon **302** typically attaches to the distal end of the outer guide **101**. The steering tendon **302** allows the distal end of the outer guide **101** to be deflected and thereby assists the inner guide **100** in locating the feature of interest. FIG. 3B illustrates a configuration at the outer guide distal end where the steering tendon **302** is attached to a steering

plate **303**. The steering plate **303** is semi-circular in shape and is fixedly attached to the distal end of the outer guide **101**.

The steering tendon **302** can be accessed from the proximal end of the guide catheter. Application of a pulling force on the steering tendon **302** causes the outer guide **101** to deflect at the deflection location **305**. In one configuration, the guide catheter can include a steering handle **103** that can provide convenient control of the steering tendon **302**. The steering handle **103** is typically pivotably attached to the guide handle **102**. The steering handle **103** connects to the steering tendon **302** and applies a tensile force on the steering tendon **302**.

It may be useful to orient the steering tendon **302** and the deflection location **305** perpendicular to the longitudinal pre-stress line **106**. As shown in FIG. 3B, two longitudinal pre-stress lines **106** are both 90 degrees from the steering tendon **302** when viewed from a transverse cross section.

The deflection location **305** is typically preformed in the outer guide **101** during manufacture. A number of fabrication methods for forming the deflection location **305** are possible, and such methods are well known in the art. One such method is to mold or thermoset a bend in the outer guide **101**. Another method for forming a deflection location **305** is to impart a change in stiffness in the outer guide **101** at the desired location. A change in stiffness can be created by altering outer guide **101** wall geometry (e.g. diameter, wall thickness) or by making a transition in wall materials at the region of the deflection location **304**.

FIGS. 2C and 2D illustrate the action of the steering tendon **302** on the outer guide **101**. In FIG. 2C, the outer guide has an initial bend angle **202** at a deflection location **305**. FIG. 2D shows the effect of applying a force on the handle **103**, the direction of movement being represented by the bold arrows. Pulling the handle **103** in a proximal direction applies a tensile force to the steering tendon **302**. The tensile force on the steering tendon **302** in turn causes the deflection location **305** of the outer guide **101** to assume a new angle **203**. The angle **203** can be adjusted to assist in directing the distal end of the inner guide **100** to the feature of interest. The initial angle **202** may range from about 0 to about 100 degrees. The steering tendon **302** can impart a change of up to about 45 degrees on the initial angle **202**, depending on catheter geometry.

Turning now to FIG. 4A, another embodiment of the catheter according to the present invention is illustrated. FIG. 4A illustrates a pre-formed bend **400** on the inner guide **100**. A pacing lead **405** is shown extending from the distal end of the inner guide **100**. The pacing lead **405** is a typical payload for a guide catheter embodying features of the present invention.

The guide catheter illustrated in FIG. 4A also employs an occlusion balloon **401** on the distal tip of the outer guide **101**. The occlusion balloon **401** can be inflated when the outer guide **101** is in a vessel where blood flow occlusion is desired. Blood flow can be temporarily occluded in this way before injecting a contrast media, for example. The occlusion balloon **401** is typically inflated by a fluid injected from a proximal end of the outer guide **101**. Methods of mounting and actuating the occlusion balloon **401** are well known in the art.

FIG. 4B illustrates an occlusion balloon **402** mounted on the distal end of the inner guide **100**. Actuation and disposition of the occlusion balloon **402** is similar to that described for the occlusion balloon **401** mounted on the outer guide **101**. In another aspect of the invention, the payload **107** (as seen in FIG. 1B) may include an occlusion device.

Also shown in FIG. 4B are electrodes **403** mounted on the distal end of the outer guide **101**. The electrodes **403** are typically flush mounted, and are connected to at least one conductor **406** that is disposed between the distal and proximal ends of the inner guide **100**. FIG. 4C shows electrodes

404 mounted in a similar fashion, but in this case mounted on the inner guide 100. The electrodes 404 are connected to at least one conductor 407 that is disposed between the distal and proximal ends of the inner guide 100. The electrodes 403 and 404 can be used for electrophysiological (EP) purposes, such as EP mapping structures within the heart. Those skilled in the art will appreciate that other measurement devices, such as a piezoelectric crystal for measuring fluid pressure, can also be mounted on the inner and outer guides 100,101 in a similar fashion as described for the electrodes 403,404.

It will, of course, be understood that various modifications and additions can be made to the preferred embodiments discussed hereinabove without departing from the scope of the present invention. Accordingly, the scope of the present invention should not be limited by the particular embodiments described above, but should be defined only by the claims set forth below and equivalents thereof.

What is claimed is:

1. A guide catheter having proximal and distal ends, comprising:

an outer guide having an open lumen and a longitudinal pre-stress line extending between a distal end and a proximal end of the outer guide, at least the distal end of the outer guide dimensioned for passage into a patient's coronary sinus and having either varying stiffness or a pre-formed bend at a deflection location;

an inner guide having an open lumen and a compliancy greater than that of the outer guide, the inner guide movably displaceable within the open lumen of the outer guide such that the inner guide can rotate axially and translate longitudinally relative to the outer guide, at least a distal end of the inner guide having a pre-formed curve and dimensioned for passage into the patient's coronary sinus;

a guide handle comprising a steering mechanism and having a distal end connected to the proximal end of the outer guide, the guide handle separable into at least two sections such that guide handle separation splits the outer guide along the longitudinal pre-stress line at the proximal end of the outer guide, the outer guide further splitting along the longitudinal pre-stress line upon outer guide retraction in a proximal direction relative to the inner guide;

a steering tendon anchored at a distal tip of the outer guide, extending along the outer guide, and coupled to the steering mechanism; and

a guide tip defined by a distal tip of the inner guide when extended beyond the distal tip of the outer guide, the guide tip modifiable in terms of tip angle, tip shape, and tip length in response to changes in steering tendon tension and relative axial and longitudinal movement between the distal end of the inner guide and the distal end of the outer guide having the varying stiffness.

2. The catheter of claim 1, wherein the inner guide has a longitudinal stiffness that facilitates maintaining of inner guide position when the outer guide is retracted in a proximal direction relative to the inner guide.

3. The catheter of claim 1, wherein the pre-formed curve of the inner guide is located about 1 centimeter to about 10 centimeters from the distal tip of the inner guide and comprises a bend angle ranging from about 20 degrees to about 100 degrees.

4. The catheter of claim 1, wherein the inner guide comprises a lubricious lining along its inner surface.

5. The catheter of claim 1, further comprising an occlusion balloon provided at the distal end of the inner guide.

6. The catheter of claim 1, further comprising an occlusion balloon provided at the distal end of the outer guide.

7. The catheter of claim 1, further comprising mapping electrodes provided at the distal end of the inner guide.

8. The catheter of claim 1, further comprising mapping electrodes provided at the distal end of the outer guide.

9. The catheter of claim 1, wherein the steering mechanism is supported by one of the at least two sections of the guide handle.

10. The catheter of claim 1, wherein the steering mechanism comprises a pivotally mounted steering handle.

11. The catheter of claim 1, wherein the inner guide is configured to receive a pacing lead having an outer diameter smaller than an inner diameter of the inner guide.

12. The catheter of claim 1, wherein the outer guide, after removal of the inner guide from the outer guide, is configured to receive a pacing lead having an outer diameter smaller than an inner diameter of the outer guide.

13. A guide catheter having proximal and distal ends, comprising:

an outer guide having an open lumen and two opposing longitudinal pre-stress lines extending between a distal end and a proximal end of the outer guide, at least the distal end of the outer guide dimensioned for passage into a patient's coronary sinus and having either varying stiffness or a pre-formed bend at a deflection location;

an inner guide having an open lumen and a compliancy greater than that of the outer guide, the inner guide movably displaceable within the open lumen of the outer guide such that the inner guide can rotate axially and translate longitudinally relative to the outer guide, at least a distal end of the inner guide having a pre-formed curve and dimensioned for passage into the patient's coronary sinus;

a guide handle comprising a steering mechanism, two opposing handle members, a channel defined within the guide handle between the two handle members, and a distal end connected to the proximal end of the outer guide, the guide handle comprising two opposing seams along which the guide handle is separable into at least two sections, each of the two sections including a respective one of the two handle members, the two opposing seams of the guide handle aligned longitudinally with the two opposing longitudinal pre-stress lines of the outer guide, the two handle members extending proximally of the outer guide's proximal end and positioned such that relative movement between the two handle members concentrates leverage assisted force at the proximal end of the outer guide to split the outer guide along the two opposing longitudinal pre-stress lines, the channel dimensioned to allow passage of the distal end of the inner catheter through the channel and into the open lumen of the outer guide such that the inner guide is longitudinally displaceable and axially rotatable within, and relative to, the guide handle;

a steering tendon anchored at a distal tip of the outer guide, extending along the outer guide, and coupled to the steering mechanism; and

a guide tip defined by a distal tip of the inner guide when extended beyond the distal tip of the outer guide, the guide tip modifiable in terms of tip angle, tip shape, and tip length in response to changes in steering tendon tension and relative axial and longitudinal movement between the distal end of the inner guide and the distal end of the outer guide having the varying stiffness.

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14. The catheter of claim 13, wherein the steering tendon is situated along the outer guide positioned 90 degrees relative to the two opposing pre-stress lines of the outer guide.

15. The catheter of claim 13, wherein the steering mechanism comprises a pivotally mounted steering handle. 5

16. The catheter of claim 13, wherein the inner guide has a longitudinal stiffness that facilitates maintaining of inner guide position when the outer guide is retracted in a proximal direction relative to the inner guide. 10

17. The catheter of claim 13, wherein the pre-formed curve of the inner guide is located about 1 centimeter to about 10 centimeters from the distal tip of the inner guide and comprises a bend angle ranging from about 20 degrees to about 100 degrees. 15

18. The catheter of claim 13, further comprising an occlusion balloon provided at the distal end of one or both of the inner guide and the outer guide. 20

19. The catheter of claim 13, further comprising mapping electrodes provided at the distal end of one or both of the inner guide and the outer guide. 25

20. A method, comprising:

advancing a guide catheter to a location in a patient's right atrium proximate an ostium of the patient's coronary sinus, the catheter comprising:

an outer guide having an open lumen and a longitudinal pre-stress line extending between a distal end and a proximal end of the outer guide, at least the distal end of the outer guide dimensioned for passage into the coronary sinus and having either varying stiffness or a pre-formed bend at a deflection location; 25

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an inner guide having an open lumen and a compliancy greater than that of the outer guide, the inner guide movably displaceable within the open lumen of the outer guide such that the inner guide can rotate axially and translate longitudinally relative to the outer guide, at least a distal end of the inner guide having a pre-formed curve and dimensioned for passage into the coronary sinus;

a guide handle comprising a steering mechanism and having a distal end connected to the proximal end of the outer guide, the guide handle separable into at least two sections;

a steering tendon anchored at a distal tip of the outer guide, extending along the outer guide, and coupled to the steering mechanism; and

a guide tip defined by a distal tip of the inner guide when extended beyond the distal tip of the outer guide;

modifying the guide tip in terms of tip angle, tip shape, and tip length to locate and cannulate the coronary sinus by changing steering tendon tension and relative axial and longitudinal movement between the distal end of the inner guide and the distal end of the outer guide having the varying stiffness;

delivering a payload through the inner guide after cannulation of the coronary sinus; and

retracting the outer guide relative to the inner guide by splitting the guide handle and the outer guide along the longitudinal pre-stress line without dislodging the payload.

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